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## 02220 - TRENCHING, BACKFILLING AND COMPACTION OF UTILITIES

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(Revised 11/06/06)

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## **[PART 1 – GENERAL](#)**

The Contractor shall furnish all labor, materials, tools, and equipment to perform all work and services necessary for or incidental to the completion of all underground utilities as shown on the drawings and as specified in the Contract Documents.

Contractor shall be responsible for coordination of work of all other trades.

### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this specification.
- B. Section 01000 – GENERAL REQUIREMENTS.
- C. [Section 02720](#) – STORM DRAINAGE.
- D. [Section 02730](#) – SANITARY SEWER.
- E. [Section 02660](#) – WATER DISTRIBUTION.
- F. [Section 02500](#) – BASE COURSE AND PAVING.
- G. [Section 02200](#) – EARTHWORK.

### **1.2 SUMMARY**

- A. This section includes:
  - 1) Excavating and backfilling trenches for buried water, sewer, and storm drainage pipe systems, buried utility structures, and appurtenances.
  - 2) Preparing subgrade for buried water, sewer, and storm drainage systems, buried utility structures and appurtenances.

- B. Construction and materials related to this section but specified in other specification sections:
  - 1) Section 01000 – *General Requirements*: Landscaping, Seeding and Groundcover, and Erosion Control.
  - 2) Section 02200 – *Earthwork*: site clearing, grubbing, topsoil removal, tree protection, roadway, and paving.

### 1.3 DEFINITIONS

For the purposes of this specification, the following definitions refer to sanitary sewer, storm drainage and water distribution systems that come under the authority of the City of Lynchburg, Virginia as specified within this section and other sections of this manual.

- A. **Backfill**: Soil materials used to fill an excavated trench:
  - 1) **Initial Backfill** (Select Earth Backfill): Backfill placed beside and 12 inches over the top of the pipe in a trench, including haunches to support sides of pipe.
  - 2) **Final Backfill** (Common Earth Backfill): Backfill placed over the initial backfill to fill a trench.
- B. **Bedding Course**: Layer placed over the excavated subgrade in a trench before laying pipe.
- C. **Foundation Stone**: Clean well-graded stone, authorized by the City Engineer, used to strengthen and/or provide support to an otherwise weak subgrade. Foundation stone is placed, and the subgrade improved before bedding stone is placed.
- D. **Trench Rock Excavation**: Removal and satisfactory disposal of all unsuitable materials, which, in the opinion of the City Engineer, cannot be excavated except by drilling, blasting, wedging, jack hammering or hoe ramming. It shall consist of undecomposed stone, hard enough to ring under hammer. All boulders containing a volume of more than ½ cubic yard and/or solid ledges, bedded deposits, unstratified masses and conglomerations of material so firmly cemented as to possess the characteristics of solid rock which cannot be removed without systematic drilling, blasting, or hoe ramming will be classified as rock.
- E. **Structures**: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- F. **Subgrade**: Surface or elevation remaining after completing the trench excavation or, the top surface of a backfill (stone or soil) immediately below the pipe conduit or pipe bedding, as applicable.

- G. **Trench Borrow (Select):** Trench borrow shall consist of approved material imported from off-site for use as fill or backfill required to be placed in trenches either as initial select earth backfill or final common earth backfill. Trench borrow shall not be used until all suitable trench excavation material has been placed in the trench, unless authorized by the City Engineer. The Contractor shall make his own arrangements for obtaining borrow and pay all costs involved, unless otherwise designated on the plans and in the contract documents. Borrow material must be approved by the City Engineer prior to use.
- H. **Regular Excavation:** Removal and disposal of any and all material above subgrade elevation, except solid rock and undercut excavation, located within the limits of construction.
- I. **Undercut Excavation:** Undercut excavation shall consist of the removal and satisfactory disposal of all unsuitable material located below subgrade elevation. Where excavation to the finished grade section results in a subgrade or slopes of muck, peat, matted roots, etc., the Contractor shall remove such material below the grade shown on the plans or as directed; and areas so excavated shall be backfilled with approved select earth borrow or stone as directed by the City Engineer.

#### 1.4 SUBMITTALS

- A. Submit product data for and a sample of the following in accordance with Section 01000, *General Requirements*. Fully document each with specific location or stationing information, date and other pertinent information.
  - 1) Stabilization/Separation fabric
  - 2) Drainage Fabric
  - 3) Metallic locating tape
- B. **Material Test Reports:** Provide from a qualified testing agency test results and interpretation for compliance of the following requirements indicated:
  - 1) Classification according to ASTM D2487 of each on-site or borrow soil proposed for backfill, unless otherwise directed by the City Engineer.
  - 2) Laboratory compaction curve according to ASTM D698 for each on-site or borrow soil material proposed for backfill.
- C. **Blasting:** See Section 01000 – *General Requirements*.
- D. **Bury Depth Computations:** Computations justifying pipe bury when bury depth exceeds the allowable depth shown in this specification. Provide method, applicable charts/graphs, print outs, assumptions, etc.

## 1.5 QUALITY ASSURANCE

- A. **Geotechnical Testing Agency Qualifications:** An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing as documented according to ASTM D 3740 and ASTM E 548.
- B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.
- C. The Contractor shall comply with the latest revision of the Virginia Occupational Safety and Health Standards for the Construction Industry as adopted by the Safety and Health Codes Commission of Virginia.
- D. The Contractor shall comply with Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, "Virginia Erosion and Sedimentation Control Handbook," latest revision.
- E. Comply with applicable requirements of NFPA 495, "*Explosive Materials Code*."
- F. Comply with "*Gravity Sanitary Sewer Design and Construction*," ASCE Manuals and Reports on Engineering Practice – NO. 60, WPCF Manual of Practice NO. FD-5.
- G. Comply with Uni-Bell PVC Pipe Association "*Handbook of PVC Pipe: Design and Construction*," 3rd ed. Dallas: UNI, 1991 for the installation of PVC piping, latest revision.
- H. Materials and operations shall comply with the latest revision of the Codes and Standards listed below:

### **American Society for Testing and Materials**

<b>ASTM C 33</b>	Concrete Aggregates.
<b>ASTM D 698</b>	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft <sup>3</sup> ) (Standard Proctor).
<b>ASTM D 1556</b>	Standard Method of Test for Density of Soil in Place by the Sand-Cone Method.
<b>ASTM D 1557</b>	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft <sup>3</sup> ) (Modified Proctor).
<b>ASTM D 2049</b>	Standard Method of Test for Relative Density of Cohesionless Soils.
<b>ASTM D2167</b>	Standard Method of Test for Density of Soil in Place by the Rubber-Balloon Method.
<b>ASTM D 2487</b>	Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

<b>ASTM D 2922</b>	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
<b>ASTM D 4253</b>	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
<b>ASTM D 4254</b>	Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
<b>ASTM D 4318</b>	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

**American Association of State Highway & Transportation Officials**

<b>AASHTO T99</b>	The Moisture-Density Relations of Soils using a 5.5-pound Rammer and a 12-inch drop.
<b>AASHTO T180</b>	The Moisture Density Relations of Soils using a 10-pound Rammer and an 18-inch drop.
<b>AASHTO M 145</b>	The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

**American Water Works Association**

<b>AWWA C600</b>	Installation of Ductile Iron Water Mains and Their Appurtenances.
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**1.6 STANDARD ABBREVIATIONS**

<b>ANSI</b>	American National Standards Institute
<b>AREA</b>	American Railway Engineers Association
<b>DEQ</b>	Department of Environmental Quality
<b>DIP</b>	Ductile Iron Pipe
<b>MSDS</b>	Material Safety Data Sheets
<b>OHSA</b>	Occupational Safety and Health Administration
<b>PVC</b>	Polyvinyl Chloride Plastic Pipe
<b>RCP</b>	Reinforced Concrete Pipe
<b>PCP</b>	Plain Concrete Pipe (Non-Reinforced)
<b>VDH</b>	Virginia Department of Health
<b>VDOT</b>	Virginia Department of Transportation

## 1.7 TESTING SERVICES

- A. The Testing Laboratory shall be selected by the Contractor/Developer and approved by the City Engineer and will be responsible for conducting and interpreting tests. The Testing Laboratory shall state in each report whether or not the test specimens conform to all requirements of the Contract Documents and specifically note any deviation.
- B. Specific test and inspection requirements shall be as specified herein.

## 1.8 PROJECT CONDITIONS

- A. **Demolition:** Demolish and completely remove from the site existing underground utilities indicated on the plans to be removed.
- B. **Environmental:** Before crossing or entering into any jurisdictional wetlands, Contractor shall verify whether or not a wetlands permit has been obtained for the encroachment and whether special restrictions have been imposed. Care shall be taken to prevent draining or otherwise destroying non-permitted wetlands. Restore as stated on either the project drawings, the contract documents, and/or as noted in the permit.

## 1.9 COORDINATION

- A. At the direction of the City Engineer, temporary pumping/bypass of sewerage flow may be required to be provided. See Section 02730 - *Sanitary Sewer* for bypass pumping requirements and procedures.
- B. See Section 02660 – *Water Distribution* for valve operation requirements.
- C. Coordinate tie-ins to municipal system with the City of Lynchburg.
- D. When traffic signals or their appurtenances are likely to be damaged or interfered with as a result of the construction, coordinate temporary operation with the City of Lynchburg Traffic Engineer. Provide a minimum of 48 hours notice prior to anticipated disturbance or interruption.

## **PART 2 – PRODUCTS**

### 2.1 BEDDING AND BACKFILL

- A. **Backfill Around Structures:** Backfill shall be approved by the City Engineer and shall be free from large or frozen lumps, wood, or rocks more than 3 inches in their greatest dimension or other extraneous material. Porous backfill shall conform to the requirements of applicable sections of the VDOT *Road and Bridge Specifications*.
- B. **Bedding Material:** VDOT #57, #68, or #78 stone.
- C. **Coarse Aggregate Backfill:** See applicable VDOT *Road and Bridge Specifications* for properties and gradation of VDOT #57 stone.

**D. Common Earth Backfill**

- 1) **Satisfactory Soils:** ASTM D 2487 soil classification group (Unified Classification System) GW, GP, GM, SW, SM, SC, ML, and CL or a combination of these group symbols; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
  - 2) **Unsatisfactory Soils:** ASTM D 2487 soil classification group CH, MH, OH, OL and PT; soils which contain rock or gravel larger than 3 inches in any dimension, debris, waste frozen materials, vegetation, and other deleterious matter. Unsatisfactory soils also include satisfactory soils not maintained within 20-percent of optimum moisture content at time of compaction, unless otherwise approved by the City Engineer.
- E. Dense Graded Aggregate Backfill:** VDOT #21A stone.
- F. Excavation:** All excavation material shall be classified as either Rock or Regular Earth Excavation.
- G. Flowable Fill Concrete Backfill:** Concrete strength shall be liquid enough to flow, be self-leveling, and have an ultimate minimum strength 225 psi (this product is a combination of sand and Portland cement).
- H. Foundation Stone:** Foundation/Trench Stabilization Material: VDOT #1 or #2 stone.
- I. Select Earth Backfill:** Select earth backfill shall be free of debris, roots, frozen materials, organic matter, rock, or gravel larger than 1 inch in any dimension, or other harmful matter and shall generally meet VDOT *Road and Bridge Specifications*, Section 207 – *Select Material* for properties and gradation. Sand and rock dust are acceptable materials.
- J. Topsoil:** Topsoil shall consist of friable clay loam, free from roots, stones, and other undesirable material and shall be capable of supporting a good growth of grass. Topsoil shall be free of material greater than 1 inch in any dimension.

**2.2 MISCELLANEOUS****2.2.1 GEOTEXTILE FABRIC**

See the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, *Virginia Erosion and Sedimentation Control Handbook*, latest edition.

## 2.2.2 METALLIC LOCATING TAPE

Acid and alkali resistant polyethylene film tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

**Blue:** Water Systems

**Green:** Sewer systems

## **PART 3 – EXECUTION**

### **3.1 PREPARATION**

#### **3.1.1 GENERAL REQUIREMENTS APPLYING TO ALL AREAS**

- A. Contractor shall plan construction to minimize disturbance to properties adjacent to the sewer, water, and storm lines.
- B. The City Engineer reserves the right to limit the width of land to be disturbed and to designate on the drawings or in the field certain areas or items within this width to be protected from damage.
- C. Any grading or excavation required for equipment travel during the course of construction as well as erosion control, access or haul road installation and removal, restoration, seeding and ground cover shall be provided by the Contractor at no additional cost.
- D. The Contractor shall be responsible for damage to areas or items designated by the City Engineer to be protected. Repairs to, replacement of, or reparations for areas or items damaged shall be made at the Contractor's expense to the satisfaction of the City Engineer before acceptance of the completed project.
- E. The Contractor shall protect all buildings, structures, and existing utilities located along the utility line. Hand trenching, shoring, or other methods may be required at no additional cost.
- F. Any fences disturbed by the Contractor shall be repaired to a condition equal to or better than their original condition or to the satisfaction of the City Engineer at no additional cost.
- G. Contractor shall obtain written permission from property owners for use of any access other than ones located within rights-of-way. Written permission shall contain conditions for use and restoration agreements between property owner and Contractor. No additional compensation will be made for such access.
- H. All areas disturbed shall be restored to a condition equal to or better than their original condition and shall be graded to drain.



- I. The Contractor shall replace or repair all damaged or destroyed hedgerows and property corners. Protection of and restoration of damaged or destroyed property corners shall be in accordance with the requirements of Section 01000 – *General Requirements*, Construction Staking.
- J. When a property owner requests that a tree(s) within construction limits remain, a waiver shall be signed between the property owner and the City.

### 3.1.2 CONSTRUCTION LIMITS

- A. Contractor shall not disturb any areas outside the limits contained in this section without the express written permission from the City Engineer.
- B. The following widths measured from the centerline of the sewer, water, and storm drainage lines shall be considered the allowable working area and be referred to as the “construction limits.”

Pipe Size	Distance from C/L	Total Allowable Width
12" or smaller	15 feet	30 feet
15" to 18"	20 feet	40 feet
24" and larger	25 feet	50 feet

The Contractor shall protect all areas outside these construction limits unless written variations are granted by the City Engineer.

### 3.1.3 CLEARING AND GRUBBING

- A. This work shall consist of clearing, grubbing, removing, and disposing of all vegetation and debris within the limits of construction, as designated on the plans or as required by the City Engineer. The work shall also include the preservation from injury or defacement of all vegetation or objects designated to remain.
- B. The Contractor shall clear and grub the surface as required for the full length of the trench within the rights of way or easements or within the construction limits indicated on the drawings. The width shall not exceed that width as specified herein. The Contractor shall remove only those trees and shrubs absolutely necessary to allow for the construction.
- C. Prior to commencement of clearing, Contractor shall notify the City Construction Coordinator 48 hours in advance.
- D. The Contractor shall provide barricades, fences, coverings, or other types of protection necessary to prevent damage to existing improvements, not indicated to be removed, and improvements on adjoining property. All improvements damaged by this work shall be restored to their original condition or to a condition acceptable to the owner or other parties or authorities having jurisdiction.

**E. Protection of Trees and Vegetation**

Contractor shall protect existing trees and other vegetation indicated by the City Engineer to remain in place against cutting, breaking, or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary fences or barricades as required to protect trees and vegetation to be left standing at no additional cost.

Trees and shrubs that are to remain within the construction limits will be indicated on the drawings or conspicuously marked on site.

Carefully and cleanly cut roots and branches of trees indicated to remain where the roots and branches obstruct construction of the utility line. If directed by the City Engineer, the Contractor shall provide protection for roots and branches over 1 ½ inches diameter that are cut during construction operations. Temporarily cover all exposed roots with wet burlap to prevent roots from drying out. Provide earth cover as soon as possible.

Damaged trees and vegetation designated to remain shall be repaired or replaced at Contractor's expense in a manner acceptable to the City Engineer if they are damaged by construction operations. Repair tree damage as directed by a qualified tree surgeon.

- F. All brush, tree tops, stumps, and debris shall be hauled away and disposed of in accordance with applicable laws and regulations. The Contractor shall clean up debris resulting from clearing operations continuously with the progress of the work and remove promptly all salvageable material that becomes his property and is not to be reused in construction. Sale of material on the site is prohibited. Debris from the site shall be removed in such a manner as to prevent spillage. Keep pavement and area adjacent to site clean and free from mud, dirt, dust, and debris at all times. Unless otherwise noted, all trees with diameters of 6 inches or larger, measured at the base, cut on any project shall be cut into fireplace lengths, 24 inches, stacked within the "construction limits" at a location suitable to the property owner. Contractor shall not remove any wood from this project without written authorization from the City Engineer. No additional compensation shall be made if removal of trees from property is required.
- G. The method of stripping, clearing, and grubbing the site shall be at the discretion of the Contractor. However, all stumps, roots and other debris protruding through the ground surface or in excavated areas shall be completely removed and disposed of off the site by the Contractor, at his expense.
- H. Remove the existing topsoil to a depth of 6 inches or to the depth encountered from all areas in which excavation will occur. The topsoil shall be stored in stockpiles, separate from the excavated trench material, if the topsoil is to be respread. Otherwise, material shall be disposed of off-site at the Contractor's expense.

**I. Specific Requirements Applying to Developed Subdivision/Lots**

- 1) All trees located beyond 10 feet of the centerline of the sewer, water, or storm drainage line shall be protected by the Contractor. The City Engineer reserves the right to designate other trees located closer to the centerline for protection where possible.
- 2) All shrubs, hedges, or other ornamental plantings located along the line shall be protected or removed and replanted by the Contractor and guaranteed within the warranty period at no additional cost.
- 3) The Contractor shall protect septic systems, wells, or springs.
- 4) Damage to lawns shall be kept to the absolute minimum necessary for construction.
- 5) Excavated or blasted rock shall be removed from the site unless otherwise ordered by the City Engineer.

**3.1.4 PROTECTION OF EXISTING UTILITIES**

- A. Contractor is responsible for protection of existing utilities in accordance with Section 01000 – *General Requirements*.
- B. Should it become necessary to move the position of any underground structure, the Contractor may be required to do such work and shall be paid on a force account basis or on an extra work basis as specified in Section 01000 – *General Requirements*. Method of payment shall be agreed upon by the City Engineer and the Contractor prior to commencing work.
- C. If existing utilities are found to interfere with the permanent facilities being constructed under this Section, immediately notify the City Engineer and secure instructions. Do not proceed with permanent relocation of utilities until instructions are received from the City Engineer.

**3.1.5 PROTECTION OF SURFACE FEATURES**

Refer to Section 01000 – *General Requirements*.

**3.1.6 PROCEDURES FOR REPAIRING DAMAGED UTILITIES**

Refer to Section 01000 – *General Requirements*.

**3.1.7 PROTECTION OF PERSONS AND PROPERTY**

Refer to Section 01000 – *General Requirements* for requirements relating to protection and restoration of property.

## 3.2 TRENCH EXCAVATION

### 3.2.1 GENERAL

#### A. Pipe Cover

**Minimum Cover:** Unless shown otherwise on the construction documents, provide minimum trench depth indicated to maintain a minimum cover over the top of the installed item. Minimum cover on pipe is measured from top of pipe to original ground or proposed finished grade as applicable and shall be per standard details. When minimum cover cannot be maintained, alternate construction shall be approved by the City Engineer. For minimum cover requirements, see Section 02730 – *Sanitary Sewer*, Section 02660 – *Water Distribution*, and Section 02720 – *Storm Drainage*, as applicable.

- B. Remove all material from trench limits. Material of a compactible nature that can be re-used as trench backfill shall be re-installed and re-compacted to the requirements set forth in these specifications.
- C. At the Contractor's expense, dispose of all unsatisfactory material, of what ever nature, to a site which legally can accept such material as fill. Adhere to all applicable laws and ordinances regarding permitting of waste site, erosion control, zoning, etc. as may be applicable.
- D. Material of an uncompactable nature, material unsatisfactory for backfill, trash and excess material shall be removed from project site and disposed at the Contractor's expense. Where removal of unsatisfactory material is due to negligence on the part of the Contractor (i.e. resulting from inadequate shoring or bracing, failure to dewater, improper material storage exposing it to rain or flooding, or other failure to meet specified requirements), work shall be performed at no additional cost to the City. If additional material is required, the Contractor shall supply same from an approved borrow pit at no additional cost the City.

### 3.2.2 TRENCHING

- A. Where the utility line is in an existing paved area, the pavement shall be saw cut in a straight line parallel to the pipe on each side. Saw cutting operations shall be performed prior excavation to avoid excessive removal of asphalt. Care shall also be taken during the installation of pipe to avoid damage to adjoining paved surfaces.
- B. All trenches shall be excavated to the lines and grades as shown on the plans. Trenches for water lines may be curved within the limits of curvature of the pipe as allowed by AWWA C600.
  - 1) **Trench Width:** The sides of trench shall be uniform and vertical. See **Standard Detail 27.01** for trench width for sanitary sewers and storm sewers and **Standard Detail 26.01** for water lines.

- 2) **Trench Depth:** All trenches shall be excavated to accommodate the bedding as required in [Table 2220.1](#) and as shown in **Standard Details 27.01 and 26.01**, as applicable. No extra compensation will be made for stone bedding used to bring the trench up to grade other than that required in **Standard Details 27.01 and 26.01**, as applicable and specified in [Table 2220.1](#).

In excavating for the trench, it is essential that the trench bottom be uniform in grade and remains static during backfilling and under all subsequent trench conditions. The grade of the bottom of the trench shall be graded to within 0.04 foot (1/2-inch) of the plan specified grade. The stone shall be graded to the same tolerance.

Care shall be taken not to over excavate the trench. Refer to [paragraph 3.2.4](#) for over excavation specification.

- 3) **Open Trench Exposure:** Once trench is opened, proceed immediately to place specified materials in trench, or to otherwise utilize trench for intended purpose. Schedule work and order materials so that trenches are not left open for a longer period than is reasonably necessary and do not extend length limits specified in applicable specifications.

### 3.2.3 TRENCH ROCK

When rock is encountered in the trench, the City Construction Coordinator or City Engineer must be notified before any rock is blasted or removed. The City Engineer or his representative will measure the rock, after which, the rock shall be excavated. Rock shall be removed from the construction site unless otherwise approved by the City Engineer. See Section 01000 – *General Requirements* for blasting requirements.

### 3.2.4 PREPARATION OF FOUNDATION FOR PIPE LAYING

- A. The bedding surface shall provide a firm, stable, and uniform support through the entire length of the pipe.
- B. **Unsuitable Trench Subgrade/Foundation Improvement:** Notify the City when unstable materials are encountered and define by drawing station locations and limits where encountered. If the trench subgrade is found to be soft, spongy, excessively wet, unstable or in any other way unfit such that there is inadequate pipe support, when directed by the City Engineer or City Construction Coordinator, the material shall be removed for the full width of the trench, and the excavated area shall be strengthened for foundation purposes by furnishing and placing either approved crushed stone, a concrete cradle, concrete mud mat, concrete encasement or a combination of these materials. Whenever the bottom of the trench is such that it cannot be reasonably stabilized, the City Engineer may require the pipe to be laid in cradles supported on piles. These foundations shall be placed as directed by the City Engineer.

- C. **Over Excavation:** Exercise care to avoid excavations below established grade where firm earth conditions exist. Unauthorized over-excavation consists of removal of material beyond indicated subgrade elevations or side dimensions, without specific approval of the City Engineer. Unauthorized excavation shall be replaced at Contractor's expense. Where unauthorized excavations have been carried beyond points required, restore these areas to the elevations and dimensions shown on the drawings with approved fill material and compact as specified. If over-excavation occurs, such over excavation shall be replaced with clean VDOT #57 stone.

### 3.2.5 DEWATERING

- A. When ground water is encountered, the Contractor shall pump or otherwise remove any water that accumulates in the trenches or pits and shall perform all work necessary to keep the trenches or pits clear from water while pipe is being laid, masonry units are being placed, and structures are either being set or constructed. All water removed from the trench shall be conveyed in a proper manner to a suitable point of discharge and shall comply with applicable erosion and sediment control laws at no additional cost. If pumping is required between the hours of 8:00 p.m. and 6:00 a.m., engines shall be equipped as specified in Section 02730 - Sanitary Sewer, paragraph 3.5E, in order to keep noise to a minimum.
- B. No pipe shall be constructed in water and water shall not be allowed to drain through the pipe. The open end of the pipe shall be kept closed with a tight fitting plug to prevent washing of any foreign matter into the line.
- C. No structure shall be constructed in water and water shall not be allowed to flow over or rise upon any concrete or masonry structure until the work has been accepted.
- D. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. Reroute surface water runoff away from or around excavated areas.

### 3.2.6 TRENCH PREPARATION FOR PIPE

#### A. Preparation of Trenches for Gravity Pipelines

Depending upon the bedding class, the bottom of the trench for gravity pipelines shall be excavated to a minimum over depth as indicated in [Table 2220.1](#) to provide for improved pipe bedding material for the entire length of the gravity pipeline, including sewer lateral connections, except in rock where bedding shall be a minimum of 6 inches deep (see **Standard Detail 27.01**). Rock larger than 3 inches shall be removed from the trench bottom and any voids filled with soil or clean stone. The bedding shall be shaped so that the bottom quadrant of the pipe rests on the bed. Bell holes and depressions as required of the joint shall be dug after the bedding has been graded and shaped, and shall be only of such length, depth, and width as required for properly making the particular type of joint. The trench for sanitary sewers, sanitary sewer lateral connections, and storm drainage lines shall then be backfilled as indicated in [Section 3.4 - Backfilling](#).

## B. Preparation of Trenches for Water Mains

When bedding is required, the bottom of the trench for pipe line shall be excavated to a minimum over depth as indicated in [Table 02220.1](#). The trenches for water lines shall be graded to avoid local high points. Trenches shall be graded either level or on a continuous upslope to the high points designated on the drawings. Trenches shall be of such depth as to provide a minimum cover over the top of the pipe as noted in [Section 1.8 – Project Conditions](#). Pipe shall not bridge any areas. Rock larger than 3 inches shall be removed from the trench bottom and any voids filled with soil or clean stone. Bell holes shall be provided at each joint to permit proper joint assembly and proper pipe support. Rock shall be removed 6 inches below pipe and bedding shall be a minimum of 6 inches. The trench for water lines shall then be backfilled as indicated in [Section 3.4 – Backfilling](#).

### 3.2.7 TRENCHING IN FILLS

In areas where trenching for pipes will be in fills, the fills shall be brought to an elevation of at least 12 inches above the top of the pipe, and then the trench excavated in the compacted fill, as herein specified for trench excavation.

### 3.2.8 EXCAVATION FOR APPURTENANT STRUCTURES

- A. Excavate for appurtenant structures to provide at least 12 inches (minimum) clear distance between outer surface of the structure and undisturbed earth.
- B. Where rock is encountered so that a built-in-place manhole, precast structure (such as a manhole or vault), or other structure will bear over rock, remove the rock to a minimum of 12 inches below the foundation or footing of the structure and place an 12-inch cushion of VDOT #57 stone over the rock.

### 3.2.9 DEPOSITION OF EXCAVATED MATERIAL

All excavated material shall be placed in accordance with all applicable OSHA and State and local erosion and sedimentation regulations.

## 3.3 BEDDING

### 3.3.1 PIPE BEDDING CLASS DEFINITIONS

- A. **Class D Bedding** is that condition existing when the ditch is excavated slightly above grade by excavation equipment and cut to finish grade by hand. Bell holes are dug, to prevent point loading the pipe bells, so that pipe bears uniformly upon the trench bottom. Existing soil should be shovel sliced or otherwise compacted under the haunching of the pipe to provide some uniform support. The backfill to the ground surface is to be compacted to the density specified in [Table 02220.2](#). In poor soils, granular bedding material is generally a more practical, cost effective installation. The bedding factor for class D bedding is 1.1.

- B. **Class C Bedding** is that condition where the pipe is bedded in compacted granular material. The granular bedding has a minimum thickness of one-eighth the outside pipe diameter, but not less than 4 inches or more than 6 inches, and shall extend up the sides of the pipe one-eighth of the pipe outside diameter. The backfill to ground surface is to be compacted to the density specified in [Table 02220.2](#). The bedding factor for class C bedding is 1.5.
- C. **Class B Bedding** is that condition where the pipe is bedded in carefully compacted granular material. The granular bedding has a minimum thickness of one-eighth the outside pipe diameter, but not less than 4 inches or more than 6 inches, between the barrel and the trench bottom, and covering the full width of the trench and shall extend to the spring line.

The haunch area of the pipe must be fully supported; therefore, the granular material should be shovel sliced or otherwise compacted under the pipe haunch to the springline of the pipe. Both granular haunching (to the springline) and initial backfill to a minimum depth of 12 inches over the top of the sewer pipe should be placed and compacted. The remainder backfill to the ground surface is to be compacted to the density specified in [Table 02220.2](#). The bedding factor for class B bedding is 1.9.

- D) **Class B-1 Bedding** (*PVC pipe applications*) is the same as Class B Bedding except that granular backfill is placed to the top of the pipe rather than to the springline of the pipe. The backfill to the ground surface is to be compacted to the density specified in [Table 02220.2](#).
- E) **Class A Bedding** is that condition when the pipe is bedded in a cast-in-place cradle of either plain or reinforced concrete having a thickness equal to one-fourth the inside pipe diameter, with a minimum of 4 inches and a maximum of 15 inches under the pipe barrel and extending up the sides for a height equal to one-fourth the outside pipe diameter. The cradle width shall have a width at least equal to the outside diameter of the sewer pipe barrel plus 8 inches. The bedding factor for class A bedding is 2.2.

The haunching and initial backfill material above the concrete cradle should be crushed stone or a well graded granular material and carefully compacted to 12 inches above the crown of the pipe. The backfill to the ground surface is to be compacted to the density specified in [Table 02220.2](#).



**3.3.2 MINIMUM BEDDING REQUIREMENTS** (by application and type of pipe)

<b>Table 2220.1</b>			
<b>Minimum Bedding Class</b>			
<b>Application</b>	<b>Pipe Material</b>	<b>Pipe Size</b>	<b>Minimum Bedding Class</b>
<b>Sewer</b>			
	PVC	6-inches or smaller	Class B-1 <sup>a</sup> (stone to top of pipe)
	PVC	8-inch thru 15-inch	Class B-1 <sup>a</sup> (stone to top of pipe)
	DIP	4-inch thru 24-inch	Class C
	RCP	>24-inch	Class C
<b>Water</b>			
	DIP	Up to 16 inches	Class D
	DIP	≥ 16 inches	Class C
<b>Storm</b>			
	RCP inside R/W	Thru 36 inches	Class C
	RCP outside R/W	Thru 36 inches	Class D
	PCP outside R/W	Thru 24 inches	Class D
	RCP	> 36 inches	Class C
	DIP	15 thru 24 inches	Class C

<sup>a</sup>The approximate long-term deflection in different burial conditions (bedding classes, depth, degree of compaction, type backfill soil, etc.) generally can be calculated using the Modified Iowa Formula developed by Spangler and Watkins.

**Bedding requirements when rock is encountered:** When rock is encountered excavate to a depth of 6 inches below pipe and provide granular pipe bedding at a depth of 6 inches between pipe barrel and trench bottom. The bedding shall extend up the sides of the pipe 1/8 of the pipe outside diameter.

**3.3.3 BEDDING FOR STRUCTURES**

The bottom of structure excavations shall be excavated to minimum over depth of 12 inches below the bottom of the structure to provide for stone bedding. Bedding material shall be shaped and graded so that the entire bottom of the structure rests on the material for its entire area.

**3.4 BACKFILLING****A. General**

- 1) Reopen trenches that have been improperly backfilled, to a depth as required for proper compaction. Refill and compact as specified, or otherwise correct to the approval of the City Engineer and at no additional cost to the City.
- 2) Should any of the work be so enclosed or covered up before it has been approved, uncover all such work and, after approvals have been made, refill and compact as specified, all at no additional cost to the City.
- 3) Observe specific pipe manufacturer's recommendations regarding methods of backfilling and compaction.

- 4) Insure compaction of each lift to requirements stated in these specifications.
- 5) All trenches shall be backfilled prior to the completion of the day's work unless otherwise directed or permitted by the City Engineer.
- 6) Exercise extreme care in backfilling operations to avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion. Repair damages, distortions, or misalignments to full satisfaction of the City Engineer.

## B. Methods

- 1) **Select Earth Backfill:** Furnish select earth backfill where indicated on drawings and specified for compacted backfill conditions up to 12 inches above top of pipe. Comply with the following:

Care shall be taken to prevent any disturbance to the pipe or damage to newly made joints. The filling of the trench shall be carried on simultaneously on both sides of the pipe in such a manner that injurious side pressures do not occur such that the pipe could be displaced or dislodged. Do not backfill on muddy or frozen soil.

Sheeting and shoring generally should be removed only when the trench below it has become substantially filled, and every precaution shall be taken to prevent any slides of material from the sides of the trench onto or against the pipe.

- a. Hand place, shovel slice, and pneumatically tamp all select earth backfill.
- b. Place backfill in lifts not exceeding 6 inches (loose thickness).

- 2) **Common Earth Backfill:** Comply with the following:

- a. Unless otherwise specified or approved by the City Engineer, backfill the remainder of the trench, from 1 foot above the pipe to grade, with common earth fill. Before placing any backfill, all rubbish, forms, blocks, wires, or other unsuitable material shall be removed from excavation. The backfilling shall be placed in layers not over 6 inches.
- b. All areas within the limits designated on the drawings, including adjacent transition areas, shall be uniformly graded. The Contractor shall finish surfaces within the specified tolerances with uniform levels or slopes between points where elevations or existing grades are shown.
  - i. Finish subgrade areas that are to receive topsoil. Bring such areas to within 0.10 foot of required subgrade elevations.
  - ii. Shape subgrade under sidewalks to line, grade, and cross-section. Subgrade is to be brought to within 0.10 foot of required subgrade elevations.
  - iii. Shape subgrade under pavement to line, grade, and cross-section. Bring to within ½ inch of required subgrade elevations.

- c. The Contractor shall protect newly graded areas from traffic and erosion and repair and re-establish grade in settled, eroded, or rutted areas. Where compacted areas are disturbed by subsequent construction or adverse weather, the Contractor shall scarify the surface, reshape, and re-compact to the required density. If the Contractor shall fail to maintain any trench within 2 days after receipt of written notice from the City Engineer, the City Engineer may refill the said depressions and the cost of such work may be retained from monies due the Contractor or billed directly to the Contractor. In case of emergency, the City Engineer may refill any dangerous depressions without prior notice to the Contractor.
- 3) **Structure Backfill:** Take care to prevent wedging action of the backfill against structure by carrying the material uniformly around the structure so approximately the same elevation is maintained in each lift. The Contractor shall refill all excavations as rapidly as practical after completion of the structural work therein, or after the excavations have served their purpose.
- 4) **Aggregate Backfill**
  - a. **Dense Graded Aggregate Backfill:** When select earth backfill/borrow cannot be obtained, dense graded aggregate may be substituted with the City Engineer's approval.
  - b. **Coarse Aggregate Backfill:** In confined areas where compaction cannot be achieved, coarse aggregate may be substituted with the City Engineer's approval.

### 3.5 COMPACTION/DENSITY

- A. **Quality Assurance (QA):** In the course of backfilling trenches for utility installations, the City Engineer may require "Field Density Determinations" or compaction tests. When compaction tests are called for, the City Engineer will determine the location of the tests and the Developer (Owner) shall engage a qualified testing firm to perform the test. Field density determinations shall be performed in accordance with AASHTO T191, T205, and T214, modified to include material sizes used in the laboratory determination of density with nuclear field density testing device or by other approved methods. A representative of the City Engineer will observe tests and a copy of the test results and inspection report will be submitted by the testing firm directly to the City Engineer or his/her representative. When the test results indicate that the density is less than the percent specified, the Contractor shall excavate and re-compact the areas that have failed at no expense to the City. Payment for failed compaction test shall be made by the Contractor by deducting the cost from the forthcoming retainage or billed directly to the Contractor.
- B. Soil shall be compacted using equipment suitable for the material and the work area location.

- C. **Compaction Requirements:** Unless noted otherwise on drawings or more stringently by other sections of these specifications, place and insure backfill and fill materials achieve an equal or "higher" degree of compaction than undisturbed materials adjacent to the work; however, in no case shall degree of compaction fall below the following percentages of the maximum density at optimum moisture content. Tolerance is to be within +/- 20 percent of the optimum moisture content.

<b>Table 2220.2</b>	
<b>Minimum Compaction Limits</b>	
<b>Location</b>	<b>Density</b>
Beneath and within 25 feet of buildings	100% of the maximum dry density by ASTM D 698 (Standard Proctor), AASHTO T-99.
Areas under roadway pavement surfaces, shoulders, sidewalks, and curb and gutter	95% of the maximum dry density by ASTM D 698 (Standard Proctor), AASHTO T-99.
Under turf, sodded, planted, or seeded non-traffic areas	90% of the maximum dry density by ASTM D 698 (Standard Proctor), AASHTO T-99.

- D. **Minimum Compaction Testing Frequency:** Refer to Section 02200 – *Earthwork*, paragraph 3.4 – Subgrade Compaction Testing and Control.

### 3.6 SERVICE CUTS, DIRECTIONAL BORED OR PUNCHED SERVICES

- A. **Open Trenches:** Sewer lateral and water service connections that cross paved streets shall be installed by saw cutting the pavement and opening the trench.

Lateral and service connection trenches shall be backfilled as specified for gravity sewers and for water lines, as applicable. See [Section 1.8 – Project Conditions](#) of this specification.

- B. **Directional Boring or Punching:** At the direction of the City Engineer, service pipes may be required to be "punched" or "directional bored" beneath the pavement.

### 3.7 PAVEMENT REPAIR AND REPLACEMENT

Refer to specification Section 02500 – *Base Coarse and Paving*.

### 3.8 HIGHWAY CROSSING

Refer to specification Section 02730 – *Sanitary Sewer* and Section 02660 – *Water Distribution*.

### **3.9 MISCELLANEOUS**

#### **3.9.1 IDENTIFICATION OF NEW SANITARY SEWER LINES (Metallic Locating Tape)**

Placement of locating tape during backfill operations shall be required on all newly installed non-metallic mains and service laterals. The metallic locating tape shall be per [paragraph 2.2.2](#) of this specification and located no more than 12 inches below the final grade.

#### **3.9.2 FLOWABLE FILL CONCRETE BACKFILL**

When directed by the City Engineer, the Contractor shall backfill trenches or undercut areas with flowable fill concrete plant mix. Except for structural applications, traffic can be placed on mixture within an hour or two after placement. Final surfacing of pavements; however, should be delayed if possible at least 24 hours to allow for shrinkage and hydration of concrete. Settlement of 2 to 3 inches is to be expected.

#### **3.9.3 SALVAGE OF USEABLE MATERIALS**

Useable materials include paving blocks, Belgium blocks, Bluestone, brick, castings, and pipe etc., removed during excavation that are useable on this project or future projects as determined by the City Engineer. Such material shall be stockpiled on site or as directed by the City Construction Coordinator at no additional cost to the City. Unnecessary abuse and damage to these items shall be the Contractor's responsibility and the cost of replacement may be deducted from the retainage.

**End of Section 02220**

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